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HISTORICAL SUMMARY OF THE

[redacted]

IMAGE CHANGE DETECTOR

T & E REPORT NO. 68-12

25X1A

JUNE 1968

[redacted]

25X1A

TEST AND EVALUATION BRANCH

TPD/TSSG/NPIC

[redacted]

25X1A





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ABSTRACT

Contractual and other documents were reviewed and knowledgeable persons interviewed to compile a Test and Evaluation (T&E) history of the [redacted] 25X1A
25X1A [redacted] Image Change Detector (ICD) prototype. The ICD prototype does not operate satisfactorily, should or should not be use-tested depending on who one believes, and may be made obsolete by the Image Comparison Microstereoscope in any event.

No T&E in the "modern" sense was conducted. The contract did not have rigid specifications to which acceptance testing could be keyed. No 'before and after' operational suitability tests were documented which would constitute a proper evaluation.

The problem of interest varied with the agency concerned. NPIC's original problem of a future need for an automatic correlator does not appear to be solved by the autocorrelator developed for the ICD prototype. This correlator frequently introduced more error than had been set manually beforehand. No established reason for this was found in the documents that were reviewed.

The ICD project showed which modes of operation are beneficial and which are not. The Image Comparison Microstereoscope benefited greatly from this project.

TABLE OF CONTENTS

# 1. INTRODUCTION

## 1.1. Objectives

1.1.1. The primary objective of this report was to compile a history of the Test and Evaluation (T&E) that has been performed on the [redacted] 25X1A
25X1A [redacted] Image Change Detector (ICD) so that management can decide on the proper disposition of the machine.

1.1.2. An additional objective was to report what the original problem was that was to be solved by the ICD project.

1.1.3. The last objective was to record the results of the ICD project.

1.1.3.1. What kept the project from being successful?

1.1.3.2. What has been gained that should be applied to future problems?

## 1.2. Description of Reference Sources

1.2.1. An unofficial contract jacket kept by [redacted] was 25X1A
an important source of documents.

1.2.2. The official brown and green contract folders kept by Mr.
25X1A [redacted] was the basic source of documents.

1.2.3. The T&E Branch project folder contained the most recent documents.

25X1A 1.2.4. Three [redacted] reports were obtained from [redacted] They 25X1A
were:

25X1A 1.2.4.1. [redacted] "Change Detector Operation Manual" 2 Aug 1965

25X1A 1.2.4.2. [redacted] "Final Report, Change Detector" 1 Nov 1965

25X1A 1.2.4.3. [redacted] "Change Detector Maintenance Instructions" 1 May 1966 (Also obtained from [redacted]. 25X1A

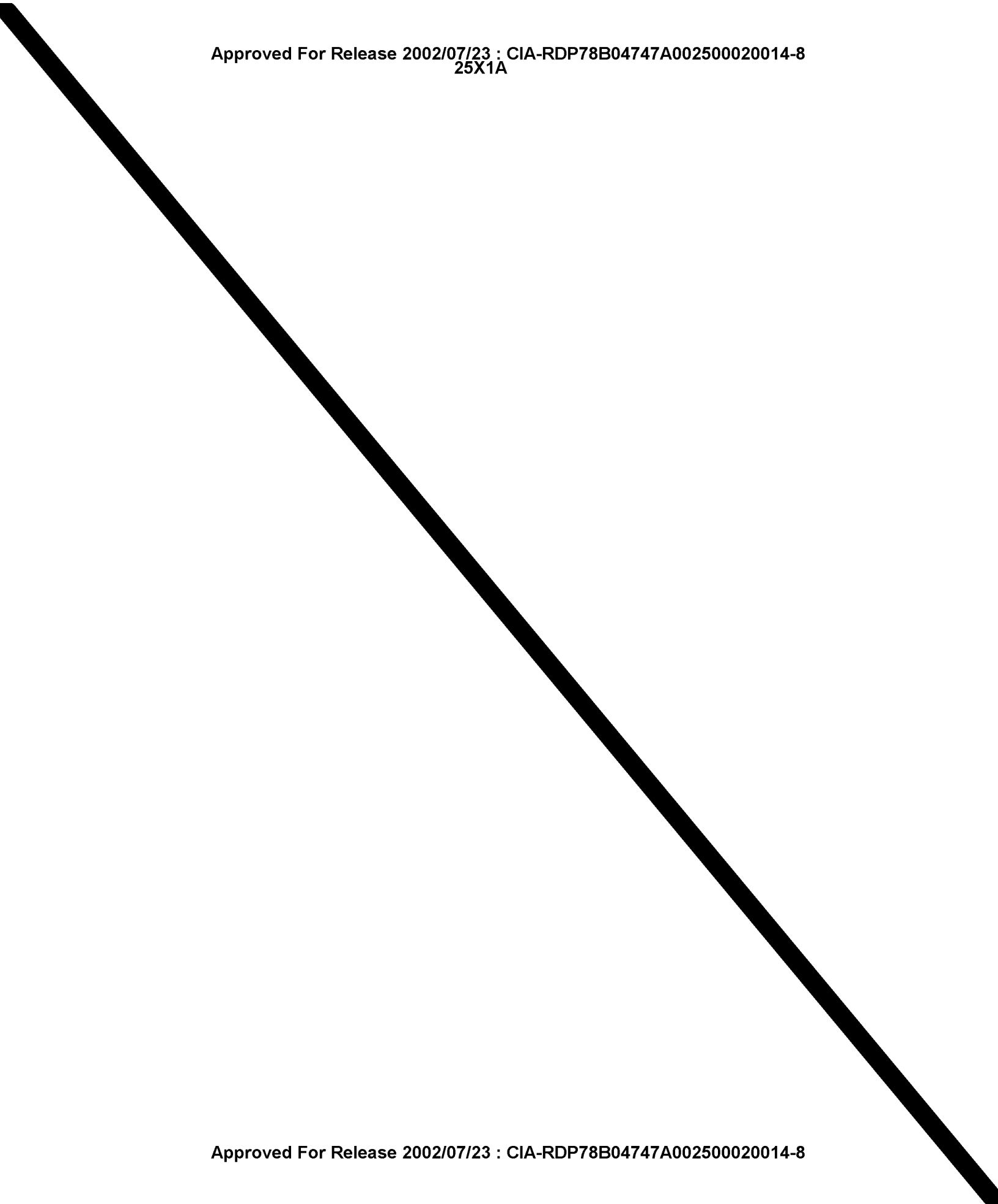
1.2.5. The official contract jacket kept by the Ames Building group was not consulted based on advice from [redacted] She said 25X1A that the Ames folder would contain no useful documents that were not in her contract jacket. The Ames Building contract jacket was sent to archival storage and would not be worth the effort required to retrieve it.

25X1A 1.3. Description of the [redacted] ICD Prototype

1.3.1. Figure 1 is a photograph of the ICD. It is also shown and briefly described on page 100 of NPIC/R-91/67 "The NPIC Equipment Summary 1967" dated June 1967.

1.3.2. The instrument is 80" high, 45" deep, and 105" long. It features two 14" television monitor screens.

1.3.3. The ICD is a device that will manually or automatically register 2 photographic images and display any differences or changes between the 2 photographs. The photographic images must be on separate 70mm rolls. The maximum roll length is 250 feet.



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## 2. SUMMARY

### 2.1. Summary of Test Results

2.1.1. Pre-Shipment Inspection

2.1.1.1. The autocorrelator correlated during the second inspection with a small residual error in the 'X' direction. This was due to misalignment of a mirror and apparently was never corrected prior to shipment.

2.1.1.2. Since most of the numerical data were design objectives rather than specifications, the inspection was made on the basis of [redacted] 25X1A success in approaching the objectives. On this basis the ICD was judged an acceptable product.

2.1.2. Final Acceptance Test

2.1.2.1. Only draft copies were found which indicated that the ICD prototype was unsatisfactory in 5 respects. The correlation unit was one of the unsatisfactory units.

25X1A 2.1.2.2. [redacted] "Final Report, Change Detector" indicated that the autocorrelation repeatability was within 0.1%.

### 2.2. Summary of Operational Suitability Results

2.2.1. The confusing situation regarding operational suitability is summarized below using direct quotations where possible and paraphrasing otherwise.

2.2.1.1. On 4 September 1964 [redacted] wrote, ". . . appears to have 25X1A





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some potential use for PAG ..."

2.2.1.2. On 7 December 1965 [redacted] drafted a memorandum 25X1A
that the same job can be done faster and better without it.

2.2.1.3. On 4 May 1966 [redacted] wrote that after the deficiencies 25X1A
are corrected it should be thoroughly use-tested. Since the deficiencies have not been corrected he should be counted as against it.

2.2.1.4. On 1 August 1967 [redacted] wrote, "... has a useful appli- 25X1A
cation..." He recommended use in the present PI cycle.

2.2.1.5. On 25 August 1967 [redacted] wrote, "... the automatic 25X1A
registration system seemed to be of little or no improvement over the manual registration system ..." "It is suggested that a competent photo interpreter make a comparison of the two..."

2.2.1.6. On 21 May 1968 [redacted] wrote, "... appears to have no 25X1A
utility in imagery exploitation."

2.3. Summary of Original Problems

There were several Government agencies or departments interested in this cooperative effort. Their objectives are listed here.

2.3.1. For NPIC it was the future need for automatic correlation.

2.3.2. For GIMRADA it was continued funding of the ICD program.

2.3.3. For the USAERDL Mine Detection Branch it was detection of Minefields from low level drone photography.

2.3.4. For the U.S. Geological Survey and the U.S. Army Scientific Liaison Advisory Group it was detection of changes in the geologic environment due to nuclear tests. etc.

2.4. Summary of ICD Project Results

2.4.1. The preponderance of evidence suggests that the automatic correlator in the ICD does not operate satisfactorily. No established reason for its unsatisfactory operation was found. [redacted] 25X1A IEG, expects the Image Comparison Microstereoscope to be far more useful for change detection than the ICD.

2.4.2. The ICD program was funded by NPIC and the [redacted] reports were 25X1A delivered to GIMRADA. No documented feedback was found.

2.4.3. No documentation was found that any personnel of the USAERDL Mine Detection Branch, the U.S. Geological Survey, and the U.S. Army Scientific Liaison and Advisory Group ever operated the ICD prototype.

2.4.4. The Image Comparison Microstereoscope project benefitted greatly from the ICD.

2.4.5. The "flicker" and "change enhance" modes of operation are useful for change detection. (See subparagraph 3.1.2.)

2.4.6. Cloud and shadow reject modes are not useful for change detection.

2.4.7. When video presentation of imagery is the correct approach the animosity towards this approach will have to be overcome. A zoom capability must be available.

## 3. CONCLUSIONS AND RECOMMENDATIONS

3.1. ICD Project Results

3.1.1. The flicker technique is useful for image change detection.

3.1.2. The change enhance mode of change detection is useful. (This mode presents all changes as light areas on a dark background.)

3.1.3. Funds should not be allocated for shadow and/or cloud reject techniques in change detection devices.

3.1.4. Anamorphic optics are needed in the Image Comparison Microstereoscope.

3.2. NPIC management should consider the following statements when formulating their decision as to the proper disposition of the ICD prototype

3.2.1. The documentation reviewed indicates that a thorough test and evaluation was not formulated and executed.

3.2.2. Much of the test and evaluation that was conducted was done with the ICD prototype partially inoperative and incompletely debugged. Some electronics not working and one mirror not aligned are cited as examples of this.

3.2.3. It is very possible that the several persons who performed the test and evaluation of this instrument did not have all the appropriate documents. If so, they may have been unaware of the needs and interests of the various interested Government Agencies as well as of NPIC. The operation manual is dated 2 August 1965 and may not have been available to those who did the T&E.

3.2.4. The evidence seems to be sufficient to properly conclude that our operational personnel do not need or want this machine.

## 4. DETAILS

### 4.1 Original Objectives or Problems

4.1.1 As noted in the documents cited in subparagraphs 4.2.2 and 4.3.13 below, NPIC's original problem was the future need for automatic correlation of 2 or more scenes. NPIC did not want the ICD prototype itself but the basis of a fully automatic servo-controlled correlator. A secondary objective was to serve the intelligence community per NSCID #8 as noted in Mr. Lundahl's memorandum cited in subparagraph 4.2.3 below.

4.1.2 GIMRADA was financially unable to underwrite the second phase of the [redacted] ICD prototype effort. Their original problem was procurement of a working prototype change detector for various applications. Those mentioned in the [redacted] proposal of 20 January 1962 were:

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4.1.2.1 Military activity by (potential) enemies

4.1.2.2 Bomb damage assessment

4.1.2.3 Minefield detection

4.1.3 ERD-EM dated 19 March 1962 was signed by [redacted] 25X1A

25X1A [redacted] of the Mine Detection Branch, USAERDL. He wrote, "Preliminary feasibility of a change detection system for Mine Detection (sic) has been demonstrated by using a set of photographs taken before and after mine burial in a desert environment." This letter also explains what they would do with the ICD prototype if it were made available to them.

4.1.4 In a letter dated 12 March 1962 the Director of the U.S. Geological Survey stated, "In addition, we are investigating on behalf of the AEC and ARPA, the geologic environment of nuclear test sites and problems related to the [redacted] program." He further stated that he would greatly appreciate having an opportunity to use the ICD prototype when it becomes available. 25X1A

4.1.5 The U.S. Army Intelligence Board in ACSIH-BD dated 6 March 1962 stated, [redacted] 25X1D

[redacted] Their letter went on to encourage GIMRADA to obtain one ICD for Army use. 25X1D

4.1.6 The U.S. Army Scientific Liaison and Advisory Group letter dated 6 March 1962 stated, "Specifically, our tests will be conducted to determine whether or not the Change Detector is applicable to the Inspection Program of Project [redacted] and to arms control techniques for disarmament." 25X1A

4.2 Procurement History

4.2.1 [redacted] "Final Report, Change Detector Studies" dated 31 October 1961 resulted from a 4-month contract that GIMRADA had with [redacted] The report stated, "The feasibility of the change detector concept has been determined by the fabrication and evaluation of a demonstration model." "This model is capable of automatic registration in two directions (X and Y) and is a video-difference readout device." It further stated, "The demonstrator model does not automatically register in scale factor and azimuth; however, the feasibil- 25X1A 25X1A

ity of implementing these two loops has been proved on the correlation equipment at [redacted] 25X1A

4.2.2 In memoranda dated 2 April 1962 and 21 March 1962 [redacted] 25X1A of NPIC emphasized that NPIC primarily wanted the automatic correlator and not the ICD prototype itself. (See also subparagraph 4.3.13 below)

4.2.3 In memorandum NPIC/D-88-62 dated 5 June 1962 Mr. Arthur C. Lundahl cited NSCID #8 and the potential technical advances in the art of photographic image correlation as reasons for NPIC's decision to fund the [redacted] ICD development. 25X1A

4.2.4 [redacted] was signed 15 June 1962 under project [redacted] 25X1A 25X1A

4.2.5 The ICD prototype was delivered to NPIC on 2 October 1964 per memorandum NPIC/P&DS/D/6-1347 dated 4 May 1966 and signed by [redacted] 25X1A

4.2.6 The ICD prototype is [redacted] in Room 1N423B, as of the date of this report, waiting for disposition. 25X1A

4.3 T&E History

According to NPIC consultant, [redacted] acceptance testing requires rigid specifications in the contract and an operational evaluation should have 'before and after' studies. Nothing approximating 'before and after' studies has been documented in the ICD files. Most of the numerical data in the contract were design objectives instead of specifications. Therefore, with the warning that no 25X1A

T&E in the 'modern' sense has been conducted, we continue.

4.3.1 A document titled "BRIEF AND EVALUATION" dated 12 March 1962 was written by [redacted] of GIMRADA. This document really only evaluates [redacted] as a better contractor than the other companies for change detector development.

4.3.2 A document titled "INSTALLATION ENGINEERING" dated 1 July 1964 is unsigned. It states that the ICD prototype has no known electromagnetic interference problems. (See subparagraph 4.3.11 below)

4.3.3 A memorandum dated 4 September 1964 was written by [redacted] of PAG. He performed, "...a preliminary evaluation of the instrument for PAG operations..." "The Change Detector appears to have some potential use for PAG in detecting changes within limited areas."

4.3.4 A memorandum dated 22 September 1964 was written by Major [redacted] assigned to NPIC from the Army. He wrote, "The purpose of this trip was to make an in-plant, pre-shipment, inspection of the Change Detector built [redacted] for NPIC." "...the non-operation of the autocorrelator lessened the value of the trip." "Because some of the cloud-and-shadow-reject electronic circuitry is on the same circuit board as the autocorrelation circuitry, the rejection features were also non-operable."

4.3.5 A report titled "RESULTS OF PRELIMINARY TESTS OF THE CHANGE DETECTOR" dated September 1964 [redacted] was authored by [redacted]

of GIMRADA. In the cover letter dated 30 November 1964 he wrote, "There was insufficient time before delivery to run the tests as originally planned..." "Some of the components were not operating at that time either." The report itself, was the first relatively thorough documented T&E of the ICD prototype.

4.3.5.1 Of the 17 items that were to be tested the 4 not meeting the design goals were;

4.3.5.1.1 Resolution: 22.6 lines/mm near maximum magnification (Design Goal: 50 lines/mm at maximum magnification)

4.3.5.1.2 Measurement: Up to 0.7 mm error (Design Goal: $\frac{1}{4}$ mm)

4.3.5.1.3 Shadow and Cloud Rejection: The components were not wired in.

4.3.5.1.4 Magnification: 187.1X maximum (Design Goal: 200X)

4.3.5.2 Evaluation type comments were;

4.3.5.2.1 "The image on the monitor screen was not in focus at maximum magnification."

4.3.5.2.2 "After the automatic correlation process, the images were sometimes displaced from the proper positions for registration." "After the automatic correlation sequence was completed, one gear did not always return to its proper position for proper correlation." "With a nudge from a finger, it would go into position, however."

4.3.5.2.3 "Tip and tilt corrections are not part of the automatic correlation process." "Any tip or tilt corrections must be made manually." "It is very difficult for the observer to be sure he is using the best settings for tip and tilt."

4.3.5.2.4 "Manual operation of the scale adjustment was satisfactory." "Although the automatic correlation did not always result in proper positioning for registration, it did not appear to be off in scale factor."

4.3.5.2.5 (Flicker is the mode where the 2 images are alternated on one monitor screen in rapid succession.) "Flicker appears to be very useful." "It seems to make changes more obvious than the video difference presentation does." "Continued use of it may strain the eyes some, but using it for a little while seems to be all right (sic)."

4.3.6 The ICD prototype was delivered to NPIC on 2 October 1964. (See subparagraph 4.2.5 above)

4.3.7 A memorandum dated 9 October 1964 was written by Major [redacted] assigned to NPIC from the Army. He wrote, "Because most of the numerical data in the contract are design objectives instead of specifications, it was not possible to make the inspection on the basis of meeting certain fixed numerical requirements." "The pre-shipment inspection was therefore made to establish [redacted] success in approaching the desired objectives." "In this respect [redacted] has produced an acceptable product." He further stated, "When placed in the 'Automatic Correlation' mode the Detector correlated the images." "There was a small residual error in the 'X' direction which was due to misalignment of the correlation mirror." "This can be corrected, but it is a time-consuming task." [redacted] would rather do the final 'tuning' after the Detector arrives at the Center..."

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4.3.8 A document titled "CHANGE DETECTOR CORRECTIONS NEEDED" dated 5 November 1964 is unsigned. It lists 24 needed corrections. Items 6 and 7 were; "6. Autocorrelation is very poor - changes attitude and X Z Y." "7. Cloud and Shadow reject not working."

4.3.9 Draft copies "Final Acceptance Tests on Change Detector" had the date 3 December 1965 lined out. The authors, [redacted] of NPIC and [redacted] stated therein that the tests were performed over a period of several months. Their results differ significantly from these reported in the report cited in subparagraph 4.3.5 above. 25X1A 25X1A 25X1A

4.3.9.1 The test differences were;

4.3.9.1.1 Sensitivity: Densities of 0.67 and 0.54 was easily noted as a change between films. Densities of 0.65 and 0.6 was barely noticeable. (Preliminary Test: A one-level difference on a 12-level gray scale could be noted.)

4.3.9.1.2 Shadow and Cloud Rejection: Did not operate satisfactorily. (Preliminary Test: The components were not wired in).

4.3.9.1.3 Correlation: Results of the automatic correlation process were not consistently good and the errors were often greater than those that had been set manually initially. (Both this test and the preliminary test reported that the time for automatic correlation was well within the design goal of 2 minutes.)

4.3.9.1.4 Durability: The only major weakness has been the reduction gears of the film drive motors which resulted in frozen bearings

several times. The design was changed since the time of the preliminary test. (Preliminary Test: No measurements were made.)

4.3.9.1.5 Tip and Tilt Adjustments: Backward tilt of 3 degrees did not meet the design goal of 5 degrees. (The preliminary test did not report this.)

4.3.9.1.6 Film Transport: A design change, after the time of the preliminary test, to obtain continuous variation of speed caused the design goals for maximum speed to be missed.

4.3.9.1.7 Magnification: 156X maximum (Preliminary Test: 187.1X maximum) The design goal was 200X maximum.

4.3.9.2 Additional significant evaluation type comments beyond those in the preliminary test report were:

4.3.9.2.1 "The cross-hairs sometimes creep off the points where they are positioned." "Because of the coarseness of the control, it is difficult to get the cross-hairs positioned over the desired point."

4.3.9.2.2 "After automatic correlation red lights indicate if correction has been made in scale and/or rotating." "If the manual button is pushed while the red light is on, the scenes move back to the original setting." "To retain the new setting the knob must be turned until the red lights are out..."

4.3.1[illegible] NPIC/P&DS-11-65 dated 15 January 1965 was signed by [redacted] This memorandum stated, "...to allow the [redacted] 25X1A 25X1A 25X1A [redacted] to complete modification and trouble-shooting of deficiencies found during test and evaluation of

25X1A the instrument in [redacted]" The 5 work items listed to correct the deficiencies do not seem to correspond with the 24 needed corrections in the document cited in subparagraph 4.3.8 above. This may indicate a case of undocumented T&E.

4.3.11 A memorandum dated 29 January 1965 was written by [redacted] 25X1A

25X1A [redacted] He wrote, "...conducted on-site broadband and narrowband electric field radiation tests in accordance with Federal

25X1A Standard 222 on the [redacted] Change Detector System located in NPIC testing room on the first floor [redacted] He recommended, "...the change detector should be placed in such a manner that the minimum distance from any outside building wall or any unprotected area within the building to the equipment is not less than fifty (50) feet." (Federal Standard 222 is titled "Radiation Standard for Communications and Other Information Processing Equipment" and is classified "Confidential.") 25X1A

25X1A 4.3.12 [redacted] "Final Report, Change Detector" dated 1 November 1965 was prepared under [redacted] 25X1A

4.3.12.1 They reported, "Limited tests using nearly identical aerial imagery have determined that the autocorrelation repeatability is within .1 percent in X, Y, azimuth and scale factor." "Although the repeatability of autocorrelation of the two films provided a good indication of the registration accuracy, the absolute accuracy was difficult to determine because the available imagery contained small but significant, amounts of relative distortion and defocusing." "Successful

correlation of typical aerial imagery containing relative azimuth errors of up to 5 degrees and scale errors between 3 and 5 percent have been achieved,..."

4.3.12.2 A predictive comment was, "...a power supply has been purchased which will generate voltage up to 25 kilovolts." "An improvement in both read-out resolution and light output is anticipated when this supply is installed." (See subparagraph 4.3.16 below)

4.3.13 A draft memorandum dated 7 December 1965 was written by 25X1A [redacted] of P&DS. He recommended "...that the device officially be turned over to GIMRADA." This was after he quoted 25X1A [redacted] 21 March 1962 memorandum (see subparagraph 4.2.2 above), "Whilst the Change Detector as such will not primarily be a tool for 25X1A our use, etc., etc." [redacted] made the closest thing to a comparative evaluation (still not a 'before and after' study) when he wrote, "In spite of all sorts of variations in target and camera orientation, aspect angle, sun angle (and, therefore, shadow pattern), snow cover, image density, etc. the experienced PI can make visual comparisons between two photos taken at different times and he can then go on and detect significant changes, usually with a minimum loss of time," "Whereas the 'pre-normalization' of the imagery required by the prototype device, before it can do a very good job, requires an expenditure of a great deal of time and, in the case of oblique coverage, it is often impossible to get two images to the point where they can be compared in a manner which will permit the detection of change." No tests

or data were cited for the preceding. [redacted] further stated, "At NPIC...virtually all interest in the device as a piece of operational equipment has been killed both because of its extremely limited resolution capabilities as well as because very few operationally oriented PI's can see even a potential need for such a device." "At least in theory, a 'change detecting' device seems as if it might be useful..." 25X1A

4.3.14 NPIC/P&DS/D/6-1347 dated 4 May 1966 was written by [redacted] Attached to this memorandum were an outline of the Test Plan, a copy of the preliminary test report (see subparagraph 4.3.5 above), and a draft copy of the final acceptance test report (see subparagraph 4.3.9 above). 25X1A

4.3.15 Form 1897 dated 26 May 1966 was signed by [redacted] 25X1A

25X1A [redacted] He wrote, "The delay in final acceptance and failure to meet some of the design objectives are attributed to official technical changes made in the contract and to the decision to deliver without a complete electronic checkout at the factory."

4.3.16 NPIC/P&DS/D/6-1415 dated 10 June 1966 was written by

25X1A [redacted] He wrote, "The optimistic note in the Acceptance Inspection Report (Memorandum for the Record, 4 May 1966), that the new power supply to be installed would greatly improve the cloud and shadow/reject modes, has not been born (sic) out following the subject installation." (The optimistic note not only appears in the document cited in subparagraph 4.3.14 but also in the [redacted] Final Report cited in 25X1A

subparagraph 4.3.12) [redacted] further stated, "To date, higher priority work has delayed further T&E on this instrument." 25X1A

4.3.17 NPIC/TDS/D-952-67 dated 1 August 1967 was written by [redacted] He evaluated the [redacted] ICD prototype to determine its usefulness as a photographic interpretation tool. He concluded, "...the [redacted] Change Detector has a useful application in the initial review of numerous photographic frames occurring in sequence on the rolls of film being compared." He recommended, "That this prototype model of the [redacted] Change Detector be used in the present photographic interpretation cycle to isolate areas of interest for further intense optical study by an experienced interpreter utilizing a light table." 25X1A 25X1A 25X1A 25X1A

4.3.18 NPIC/TDS/EP/536-67 dated 25 August 1967 was written by [redacted] He wrote, "It might be added here that in the investigation of the Change Detector the automatic registration system seemed to be of little or no improvement over the manual registration system." "It is suggested that a competent photo interpreter make a comparison of the two to determine the merit of the automatic system." 25X1A

4.3.19 IEG-131-68 dated 21 May 1968 was written by [redacted] He wrote that the ICD prototype appears to have no utility in imagery exploitation. He further wrote, "The Image Comparison Microstereoscope now under development is expected to be a far more useful instrument for use in change detection procedures." 25X1A

4.4. ICD Project Results

4.4.1. In an interview on 30 July 1968 [redacted] said that the ICD project proved the validity of the flicker technique (see subparagraph 4.3.5.2.5.), established that there are changes a PI will not want to look at, and was considered when the Image Comparison Microstereoscope project was initiated. Shadows and the X displacement due to vertical relief are examples of changes that do not interest PI's. The requirement for anamorphic optics in the Image Comparison Microstereoscope was derived from the ICD project. 25X1A

4.4.2. In an interview on 31 July 1968 [redacted] said that he learned from the ICD project that P.I's have a certain animosity toward video presentation of imagery and that they want a zoom capability. He also said that the trend is toward larger scale photography and that higher resolution CRT's are possible which might make video imagery with zoom acceptable. 25X1A

4.4.3. In NPIC/TDS/D-952-67 dated 1 August 1967 [redacted] concluded, "Change information, both obvious and hidden, is readily made apparent by use of 'flicker' and 'change enhance' modes of operation." He further concluded, "The 'shadow reject' and 'cloud reject' modes of operation were found to be of little or no value and should be removed from subsequent versions of the machine." In an interview on 31 July 1968 [redacted] stated that he learned from the ICD project that cloud reject and shadow reject techniques will not help in change detection devices. 25X1A 25X1A

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MEMO FOR RECORD 23 May 1966

2 each Operational Manual
1 Maintenance Manual (copy #2)

25X1A

for [redacted] Change Detector turned over
25X1A

to [redacted] GIMRADA, for his retention, on his visit here on 19 May 1966

25X1A

[redacted]